THE SCHUMANN'S RESONANCES AND HUMAN PSYCHOBIOLOGY

by Richard Alan Miller and
Iona Miller © 2002, 2003

PLANETARY RHYTHMS AND HUMAN HEALTH

Lewis B. Hainsworth of Western Australia seems to be the first researcher to recognise the relationship of brain-wave frequencies to the naturally circulating rhythmic signals, known as Schumann's resonances (SR), in the space between the surface of the Earth and the ionosphere. Hainsworth imparted this awareness to Dr Robert O. Becker, noted electromagnetics pollution expert, and to Harvard neurologists as early as 1975.

In 1977, this phenomenon—the relationship between brain-wave rhythms and the spectrum of the natural Earth ELF (extremely low frequency) signals—became the basis for Itzhak Bentov's *Stalking the Wild Pendulum* (Dutton, 1977). Later research confirmed a relationship to human health and well-being and even to ESP or psi phenomena.

Hainsworth sent up a clarion cry against hazardous EM (electromagnetic) pollution, whose dangers pale in comparison to the threat of technologies such as HAARP [High-frequency Active Auroral Research Program], which sends violent pulsations into the Earth's ionosphere, potentially disrupting the entire electromagnetic shield of the planet and certainly affecting the whole biosphere and thus human welfare in general.

Some research has suggested that the frequency of the basic Schumann's resonance has recently been rising in value, possibly threatening the whole biosphere, human welfare and our evolutionary future. All biological processes are a function of electromagnetic field interactions. EM fields are the connecting link between the world of form and resonant patterns. They store gestalts or patterns of information. The bridge connecting solar system resonances and brain frequencies resides in our human DNA helix, which co-evolved in the Earth's environment.

Electrical engineer Lewis B. Hainsworth, MA, was among the first to suggest that human health is linked with geophysical parameters by way of the naturally occurring Schumann's ELF. His hypothesis identified naturally occurring features which determine the frequency spectrum of human brain-wave rhythms:

> *The frequencies of naturally occurring electromagnetic signals, circulating in the electrically resonant cavity bounded by the Earth and the ionosphere, have governed or determined the 'evolution' or development of the frequencies of operation of the principal human brain-wave signals. In particular, the alpha rhythm is so placed that it can in no circumstances suffer an extensive interference from naturally occurring signals.*

... the alpha rhythm is so placed that it can in no circumstances suffer an extensive interference from naturally occurring signals.

Hainsworth concluded that the frequencies of human brain-waves evolved in response to these signals. If his hypothesis is correct, conditions for evolutionary changes in human brain-wave patterns have now been established. Furthermore, variations in these patterns can produce mild to disastrous health and behavioural changes.

The nature of the applied stimulus makes it difficult to identify the responses directly, as they are most likely to occur in the form of stress-related conditions. They will therefore show up as drastic increases in mental disturbance, antisocial behaviour, psychosomatic conditions and neurological disturbances. Some electrical field phenomena have already been linked with abnormal cell growth and a decrease in immunocompetency.

All these factors could be expected to lead to the appearance of "new" diseases, probably accompanied by a decline in resistance to many minor infections, an increase in conditions related to abnormal cell development, including cancer, birth defects and infertility, and an increase in psychological disturbance problems, e.g., drug addiction and suicide. These existing psychobiological problems could be expected to increase in scale, but could be studied for deviations from "normal" alpha cycles of 10.4 Hz, with detectable changes in psychological characteristics and mental abilities.

Hainsworth therefore strongly urged that research into widespread measurements of the natural SR signals' frequency variations and field strengths be carried out and compared with statistics for the incidence of heart attacks, suicide attempts, road accidents, social violence, domestic accidents, crimes, etc. Studies are often conducted in this inferential way (such as those by Krippner and Persinger), searching correlations between the phenomena of Earth lights and tectonic strain and reports of UFO sightings, abduction reports and other anomalous psychophysical experiences for an electromagnetic connection to temporal lobe seizures.

We strongly suggest that correlations of broad changes in the modulations of SR be studied in relationship to microwave radiation, ELF signals and HAARP for both immediate and long-term consequences. We have discussed elsewhere the obvious ramifications of such EM pollution and 10–50 Hz modulations on the human system (Miller & Miller, "Synthetic Telepathy", 2001).

We have also discussed the benefits for human well-being and relaxation from entraining with these natural rhythms (*The Diamond Body*, 1981). When a person is deeply relaxed, slow rhythmic sine-wave patterns can be detected in both the EEG and the heart/aorta resonating oscillator in the 7–8 Hz range. Resonance occurs when the natural vibration frequency of a body is greatly amplified by vibrations at the same frequency from another body.

Oscillators alter the environment in a periodic manner. Thus, standing waves in the body, whether during meditation/relaxation or

not, can be driven by a larger signal. Progressively amplified waveforms, created by resonance, result in large oscillations entraining other circuits in the body tuned to those frequencies. A hierarchy of frequencies thus couples our psychophysical selves to the harmonic frequency of the electrical charge of the Earth, which naturally pulses at the same frequencies. This is hardly a coincidence, as we are adaptive products of our environment.

Our planet is surrounded by a layer of electrically charged particles called the *ionosphere*. The lower layer of the ionosphere is roughly 60–80 kilometres (40–50 miles) from the crust, and this charged layer is known to reflect radio waves. Bombardment by HAARP signals "pushes" out this boundary layer, thus altering the natural, pulsating rhythm. Natural fluctuations in frequency occur daily, by the lunar month, and in response to solar flares.

Since the ionosphere is a highly charged layer, it forms a so-called *capacitor* with the Earth. This means that there is a difference in electrical potential between the two, the Earth being negatively charged and the ionosphere being positively charged. This potential varies somewhat, but is around 200 volts per metre. This is a fundamental type of electrical generator. The solar winds, interacting with the upper atmosphere rotation, act as the collector and brushes of a generator. The lower atmosphere can be seen as a storage battery for this gradient potential.

This electromagnetic field around the Earth can be viewed as a stiff jelly. When our bodies move and vibrate, these movements are transmitted to the environment, and vice versa. These fields not only impinge on our bodies, they also affect the charges inside our bodies. When we are standing on the ground, under normal conditions, we are grounded. Our body then acts as a sink for the electrostatic field and actually distorts the force-lines somewhat. The human body also has its own electrostatic field about itself.

The possibility exists that human health is linked with geophysical parameters by way of the naturally occurring Schumann's resonances.

These field lines are the result of the various biochemical reactions in the body. This resultant bio-field couples us to the iso-electric field of the planet (Miller & Miller, 1981).

In 1957, German physicist Dr W. O. Schumann calculated the Earth/ionosphere cavity resonance frequencies (which were named after him). He fixed the most predominant standing wave at about 7.83 Hz.

A "tuned system" consists of at least two oscillators of identical resonant frequencies. If one oscillator starts emitting, the other will be activated by the signal very shortly, in the process of resonance, entrainment or kindling (igniting the resonance phenomenon among the neurons). It becomes obvious that in deep meditation, when waves of alpha and theta rhythms cascade across the entire brain, a resonance is possible between the human being and the planet. Energy and information which are embedded in a field are transferred. Perhaps the planet communicates with us in this primal language of frequencies.

According to Hainsworth, the influence of naturally occurring Schumann's resonance signals on brain-wave pattern evolution is formally stated to show that low-power electrical fields could produce evolutionary change. The electrical fields produced by modern electro-technology are then possible sources of evolutionary change. The characteristics of some forms which might result should be considered. Some fields might inhibit survival of existing forms. Because of lack of available data, precise measurements are lacking and must therefore be quantitatively valueless. Technology not only will change, but *is* changing, human evolution. Only extensive investigation of the naturally occurring signals will give any lead in showing what results might occur.

The possibility exists that human health is linked with geophysical parameters by way of the naturally occurring Schumann's resonances. A number of attempts have been made to discover the correlation through geomagnetic and ionospheric storms. The correlation comes through the biological fact that the human system is apparently sensitive to such low-power ELF signals. We don't know what the range of such a correlation might be.

The frequency values of the SR signals are determined by the effective dimensions of the cavity between the Earth and ionosphere. Thus, any events which change these dimensions will change the resonant frequencies. As Hainsworth warned, "such events could be ionospheric storms, and could even result from a *man-made ionospheric disturbance*" (emphasis added).

Geomagnetic storms are the magnetic changes produced by ionospheric storms, and are thus associated with conditions capable of changing the SR signals. However, although such storms can produce these changes, measurement of these parameters cannot give any indication of whether the resonance signals have changed to a value outside their normal range or not. Since the undisturbed state of the ionosphere corresponds to the normal SR patterns, then ionospheric disturbances are likely to produce abnormal patterns, but will not necessarily do so in all cases. If biological response is linked to Schumann's resonance signals, this will reduce any apparent link with geomagnetic or ionospheric data.

Trying to determine the relationships between geophysical and biological conditions can become extremely complex. The frequencies of the SR signals change with ionospheric conditions. These conditions change diurnally, seasonally and with variations in solar activity, which, in turn, varies with the 11-year sunspot cycle and also with the 27–29-day lunar cycle, mainly during sunspot minimum periods. Lunar tidal changes in the height and thickness of the layers could also sometimes affect the cavity dimensions and hence the Schumann's frequencies. So can powerful ELF signals from HAARP.

It should be borne in mind that if some signal conditions are harmful, then other conditions might be beneficial. This means that if, for example, seasonal and tidal conditions have resulted in the signals being in a biologically disturbing state, then the advent of a solar flare could result in changes in the signals, bringing them into a biologically beneficial state. The converse could also occur.

If we are sensitive to ELF signals, then when these factors are considered we would expect to get confusion if we try to link any effect with geophysical changes. For instance, there could be incidences of classic states of "lunacy" in some years if damaging signals coincided with full moons, then in other years the observations and analyses would show that the effects were not lunar.

An analysis of the correlation between the incidence of ionospheric disturbance and rate of admission to Heathcote Hospital (Perth, Western Australia) for about a three-year total indicated that when a disturbance occurred then the admission rate changed. The probability

of the association being random was of the order of 2000:1 against. However, the fact that sometimes the rate went up and sometimes down showed that ionospheric storms changed the rate of incidence of mental disturbance in a way that is consistent with that change being dependent on the actual causes being linked to variations in the Schumann's resonance signals. At that point, Hainsworth decided to concentrate on trying to get some observational work going on measuring the SR signals.

Hainsworth's set-up used a 2,000-turn, 1-metre-square antenna, and another of 1/3-metre square, plus amplifiers to handle signals from 0 to 30 Hz. His amplified Schumann's signals were analysed in a laboratory. On one occasion the signal dropped to zero amplitude when a solar flare occurred, and did not start recovering for about an hour and a half afterwards. It was originally just under 7 Hz and came back at only just over 6 Hz. His next step would have been to develop a wave analyser to try to pick out individual signals. But the failing health of both himself and his wife prevented this.

The value of proceeding with his seminal work has now increased many-fold due to the threat from the proposed US Missile Defense Shield. This is the offspring of the United States' HAARP program in Alaska, whose *raison d'être,* or mission statement, allegedly dealing with national security, is vague if not purposefully misleading.

EM FREQUENCIES AND HUMAN RESPONSE

Hainsworth posed a series of questions, all of which are answered with a resounding "yes". This should lead us in the direction of extreme caution towards introducing new EM or ELF sources and ionospheric changes in our environment. He presented his data in two papers (referenced at the end of this article and posted on the website http://www.nwbotanicals.org). His questions are as follows:

1. Does the human biological system contain, use or generate any forms of electrical signal?

2. Does it respond to any of these signals?

3. Does it respond to audible signals at these frequencies?

4. Does it respond to optical signals at these frequencies?

5. Do human signals change with psychological or mental states, such as stress or problem solving?

6. Does the human system respond to any very, very low-power electromagnetic signals?

Brain waves have only been studied since about the mid-1920s, and the signal form that is apparently most widely known and identified is the alpha rhythm. The frequency of this signal varies from individual to individual, but it lies between about 7–8 Hz and 12 Hz, with an average value of 10.5 Hz. Theta and beta rhythm signals also occur, and are identifiable by EEG below the 8 Hz and above the 12 Hz frequencies. Since the discovery and measurement of these signals, a great deal of effort has been devoted to trying to work out how they originated in the first place and what determines their frequencies of operation.

In the early to mid-1950s, Schumann (a geophysicist almost certainly uninterested in neurology) suggested that electromagnetic signals might circulate at extremely low frequencies in the electrically resonant cavity between the Earth and the ionosphere. He was right. The signals came to be called "Schumann's resonances". One major component was originally predicated at a frequency of about 10 Hz. In 1959 it was measured to be slightly different. Meanwhile, the military co-opted the discovery for using ELF signals for submarine communications.

In fact, the first mode of these circulating signals has an average value of 7.8 Hz, with a typical diurnal range of from 7.2 to 8.8 Hz, and the second mode has an average value of 14.1 Hz and a range of from 13.2 to 15.8 Hz. These match the brain-wave theta rhythm and beta rhythm nicely. The blank range between the two modes is a very reasonable match with the normal frequency range of the human alpha rhythm, between 8 to 12 Hz or cycles.

Additionally, it was found that there is minimum (zero) power circulating in the Earth/ionosphere cavity at 10.4 Hz—which is virtually an exact match for the average value of the alpha rhythm. Hainsworth points out that the existence of these natural signals and the close relationship of their frequencies of oscillation were facts unknown to senior neurologists and mental health specialists as late as 1975.

Hainsworth argued that up to the end of 1979, no long-term systematic measurements of any great value were being made of the Schumann's resonance signals. Measurements were being made only intermittently for the purpose of obtaining research data for use by post-graduate geophysicists in constructing esoteric mathematical models of the ionosphere. It follows from this that, until long after the end of 1979, no figures on these signals were available. Consequently, no "expert" can produce numerical evidence to support an objection to Hainsworth's original hypothesis, since the only numerical values available are those favouring it.

However, Hainsworth left us with some open-ended questions:

7. Has any evidence ever been obtained to indicate that the human system is totally unaffected by externally applied electromagnetic fields?

8. Have any measurement programs ever been attempted to show whether the human system is (a) totally unaffected, (b) always affected, or (c) sometimes affected by naturally [or artificially] occurring electromagnetic signals?

9. Has the existence of such signals, having a close relationship with human biological signal frequencies, been known for many years?

10. Have those relationships been studied with adequate protocols in any detail?

Schumann's resonances are actually observed, by experiment, occurring at several harmonic frequencies between 6 and 50 cycles per second (one cycle equals one hertz). Specifically they are found at 7.8, 14, 20, 26, 33, 39 and 45 Hz, with a daily variation of around ±0.5 Hz.

Only as long as the properties of Earth's electromagnetic cavity remain about the same do these frequencies remain the same. Cycles may vary somewhat due to ionospheric response to solar cycle activity and properties of the atmosphere and magnetosphere. Projects, such as HAARP, which heat up or blast out the ionosphere pose a potential threat of catastrophic proportions to this interactive system.

MEASURING BRAIN WAVES BY EEG

The resonant cavity formed between the ionosphere and the Earth produces rhythmic waves capable of entraining and phase-locking with brain waves.

Even at the turn of this millennium, Hainsworth (now deceased) seems to have been unfamiliar with extensive work in brain-wave research in neurology, hypnotherapy, biofeedback and neural feedback. This research includes extensive experiments in frequency-following response (FFR) and relating brain waves and brain-wave deficiencies to psychobiological states.

The brain is a massive source of ELF signals that get transmitted throughout the body through the nervous system, which is sensitive to magnetic fields. Brain waves and natural biorhythms can be entrained by strong external ELF signals, such as stationary waves at Schumann's resonances. Entrainment, synchronisation and amplification promote coherent large-scale activity rather than typical flurries of transient brain waves. Thus, resonant standing waves emerge from the brain, which under the right conditions facilitates internal and external bio-information transfer via ELF electromagnetic waves. These SR waves exhibit non-local character and nearly instant communication capability.

The resonant cavity formed between the ionosphere and the Earth produces rhythmic waves capable of entraining and phase-locking with brain waves.

The EEG (*electroencephalograph*) measures brain waves of different frequencies within the brain. *Rhythmicity* in the EEG is a key variable in the coordination of cortical activity. Electrodes are placed on specific sites on the scalp to detect and record the electrical impulses within the brain. *Frequency* is the number of times a wave repeats itself within a second. It can be compared to the frequencies on a radio. *Amplitude* represents the power of electrical impulses generated by the brain. *Volume* or *intensity* of brain-wave activity is measured in microvolts.

Raw EEG frequency bands include *gamma* (25–60 Hz); *beta* (12–25 Hz); *alpha* (7–12 Hz); *theta* (4–7 Hz); and *delta* (less than 4 Hz). Their ranges overlap one another along the frequency spectrum by 0.5 Hz or more. These frequencies are linked to behaviours, subjective feeling states, physiological correlates, etc. Clinical improvement with EEG biofeedback is traceable to improved neuroregulation in basic functions by appeal to their underlying rhythmic mechanisms.

Schumann's resonance forms a natural feedback loop with the human mind/body. The human brain and body developed in the biosphere, the EM environment conditioned by this cyclic pulse. Conversely, this pulse acts as a "driver" of our brains and can also potentially carry information. Functional processes may be altered and new patterns of behaviour facilitated through the brain's web of inhibitory and excitatory feedback networks. Functional processes may be altered and new patterns of behaviour facilitated through the brain's web of inhibitory and excitatory feedback networks.

The brain has its own set of vibrations it uses to communicate with itself and the rest of the body. EEG equipment distinguishes these waves by measuring the speed with which neurons fire in cycles per second. At their boundaries these waves can overlap somewhat, merging seamlessly into one another—so different researchers may give slightly different readings for the range of cycles per second (Hz). The rate of cycling determines the type of activity, kindling wave after wave over the whole surface of the brain by igniting more neurons.

The frequency bands and wave characteristics are described as follows:

• **Gamma** waves (25–60 Hz) appear to relate to simultaneous processing of information from different brain areas, e.g., involving memory, learning abilities, integrated thoughts or information-rich task processing. Gamma rhythms modulate perception and consciousness, which disappear with anaesthesia. Synchronous activity at about 40 Hz appears involved in binding sensory inputs into the single, unitary objects we perceive.

• **Beta** waves (12–25 Hz) dominate our normal waking state of consciousness when attention is directed towards cognitive tasks and the outside world. Beta is a "fast" activity, present when we are alert or even anxious, or when engaged in problem solving, judgement, decision making, information processing, mental activity and focus. Nobel Prize winner Sir Francis Crick and other scientists believe the 40 Hz beta frequency may be key to the act of cognition.

• **Alpha** waves (7–12 Hz) are present during dreaming and light meditation when the eyes are closed. As more and more neurons are recruited to this frequency, alpha waves cycle globally across the whole cortex. This induces deep relaxation, but not quite meditation. In alpha, we begin to access the wealth of creativity that lies just below our conscious awareness. It is the gateway, the entry point that leads into deeper states of consciousness. Alpha waves aid overall mental coordination, calmness, alertness, inner awareness, mind/body integration and learning.

Alpha is also the home of the window frequency known as the SR, which propagates with little attenuation around the planet. When we intentionally generate alpha waves and go into resonance with that Earth frequency, we naturally feel better, refreshed, in tune, in synch. It is, in fact, environmental synchronisation.

• **Theta** waves (4–7 Hz) occur most often in sleep but are also dominant in the deepest states of meditation (body asleep/mind awake) and thought (gateway to learning, memory). In theta, our senses are withdrawn from the external world and focused on the mindscape—internally originating signals. Theta waves are associated with mystery, an elusive and extraordinary realm we can explore. It is that twilight state which we normally only experience fleetingly as we rise from the depths of delta upon waking or drifting off to

sleep. In theta, we are in a waking dream; vivid imagery flashes before the mind's eye and we are receptive to information beyond our normal conscious awareness. Theta meditation increases creativity, enhances learning, reduces stress and awakens intuition and other extrasensory perception skills.

• **Delta** waves (0–4 Hz) are the slowest but highest in amplitude. They are generated in deepest meditation and dreamless sleep. Delta waves confer a suspension of external existence and provide the most profound feelings of peace. In addition, certain frequencies within the delta range trigger the release of a growth hormone which is beneficial for healing and regeneration. This is why sleep, deep restorative sleep, is so essential to the healing process.

Rhythm & Harmonic Resonance

There is a harmonic relationship between the Earth and our mind/body. Earth's low-frequency iso-electric field, the magnetic field of the Earth and the electrostatic field which emerges from our body are closely interwoven. Our internal rhythms interact with external rhythms, affecting our balance, REM patterns, health, and mental focus. SR waves probably help regulate our bodies' internal clocks, affecting sleep/dream patterns, arousal patterns and hormonal secretion (such as melatonin).

The rhythms and pulsations of the human brain mirror those of the resonant properties of the terrestrial cavity, which functions as a waveguide. This natural frequency pulsation is not a fixed number, but an average of global readings, much like the EEG gives an average of brain-wave readings. SR actually fluctuates, like brain waves, due to geographical location, lightning, solar flares, atmospheric ionisation and daily cycles.

The most important slow rhythm is the daily rhythm sensed directly as the change in light. Rhythms connected with the daily rhythm are called *circadian* (an example is pineal gland melatonin secretion). Some experiments in the absence of natural light have shown that the basic human "clock" is actually slightly longer than one day (24 hours), and closer to one lunar day (24 hours 50 minutes).

On a slower scale, a strong influence on the Earth is its geomagnetic field, which is influenced by the following periods: the Moon's rotation (29.5 days); the Earth's rotation (365.25 days); sunspot cycles (11 or 22 years); the nutation cycle (18.6 years); the rotation of the planets (88 days to 247.7 years); and the galaxy's rotation cycle (250 million years). Very important rhythms, like hormone secretion and dominant nostril exchange, are in the order of 1–2 hours. In the range of human EEG, we have the Sun's electromagnetic oscillation of 10 Hz, while the Earth/ionosphere system is resonant at frequencies in the theta, alpha, beta-1 (low or slow) and beta-2 (high or fast) bands.

Different species often have internal generators of environmental rhythms, which can be extremely precise, up to 10^{-4}. The frequency of these oscillators is then phase-locked-loop (PLL) synchronised with the natural rhythms. Environmental synchronisation sources are often called *zeitgebers*. The mechanism of optical synchronisation can be shown. The presented rhythms should inspire a better understanding of the interaction of internal and external rhythms during specific states of consciousness.

The bioelectrical domain is geared to thalamocortical generation of rhythmic activity. In neurofeedback, what is being trained is the degree of rhythmicity of the thalamocortical regulatory circuitry. Rhythmicity manages the entire range of activation and arousal in the bio-electrical domain. One role advocated for rhythmic activity is that of *time binding*: the need for harnessing brain electrical activity, which is spatially distributed, while maintaining it as a single entity.

Brain waves indicate the arousal dimension, and arousal mediates a number of conditions. Changes in sympathetic and parasympathetic arousal "tune" the nervous system. Underarousal leads towards unipolar or reactive depression, attention deficit disorder, chronic pain and insomnia. Overarousal is linked with anxiety disorders, sleep onset problems, nightmares, hypervigilance, impulsive behaviour, anger/aggression, agitated depression, chronic nerve pain and spasticity. A combination of underarousal and overarousal causes anxiety and depression as well as ADHD.

Instabilities in certain rhythms can be correlated with tics, obsessive-compulsive disorder, aggressive behaviour, rage, bruxism, panic attacks, bipolar disorder, migraines, narcolepsy, epilepsy, sleep apnoea, vertigo, tinnitus, norexia/bulimia, suicidal ideation and behaviour, PMS, multiple chemical sensitivities, diabetes, hypoglycaemia and explosive behaviour.

Earth's low-frequency iso-electric field, the magnetic field of the Earth and the electrostatic field which emerges from our body are closely interwoven.

The brain responds to inputs at a certain frequency or frequencies. The computer can create wave-form patterns or certain frequencies that compare with the mind's neural signals in terms of mind patterns. If people can control their mind patterns, they can enter different states of being (mental relaxation, study, etc.).

So what happens when the mind is entrained with a sound or vibration that reflects the thought patterns? When the mind responds to certain frequencies and behaves as a resonator, is there a harmonic frequency that the mind vibrates to or can attune to? What does the study of harmonic resonance, sound or vibration have to do with the brain's frequency waves?

Sound waves are examples of periodicity, of rhythm. Sound is measured in cycles per second (hertz or Hz). Each cycle of a wave is, in reality, a single pulse of sound. The average range of hearing for the human ear is somewhere between 16 Hz and 20,000 Hz. We cannot hear extremely low frequencies, but we can perceive them as rhythmic.

Entrainment is the process of synchronisation, where vibrations of one object will cause the vibrations of another object to oscillate at the same rate. External rhythms can have a direct effect on the psychology and physiology of the listener. Slower tempos from 48 to 70 BPMs have been proven to decrease heart and respiratory rates, thereby altering the predominant brain-wave patterns.

Binaural beats are continuous tones of subtly different frequencies, delivered to each ear independently in stereo via headphones. If the left channel's pitch is 100 cycles per second and the right channel's pitch is 108 cycles per second, the difference between the two equals 8 cycles per second. When these sounds are combined, they produce a pulsing tone that waxes and wanes in a "wah wah" rhythm.

Binaural beats are not an external sound; rather, they are *subsonic* frequencies heard within the brain itself. These frequencies are created as both hemispheres work simultaneously to hear sounds that are

pitch-differed by key mathematical intervals (*window frequencies*). The brain waves respond to these oscillating tones by following them (*entrainment*), and both hemispheres begin to work together. Communication between the two sides of the brain is associated with flashes of creativity, insight and wisdom.

Alpha-wave biofeedback is considered a consciousness self-regulation technique, while alpha-frequency binaural beat stimulation (frequency-following response) is a passive management technique where cortical potentials entrain to or resonate at the frequency of an external stimulus. Through the self-regulation of specific cortical rhythms, we begin to control those aspects of consciousness associated with that rhythm. When the goal is alpha, either in meditation or in biofeedback, it means entraining with the primary SR.

MEASURING CHANGES IN SCHUMANN'S RESONANCES

Earth's background base frequency, or "heartbeat" (Schumann's resonances), fluctuates and may be rising dramatically. Though it varies between geographical regions, for decades the overall measurement was 7.8 cycles per second. This was once thought to be a constant. Global military communications were developed using this frequency. However, recent reports set the rate at over 11 cycles and climbing. Science doesn't know why, what to make of it or even if these reports are credible.

Gregg Braden claims to have found data collected by Norwegian and Russian researchers, and says it's not been widely reported in the USA. The authors have been unable to substantiate this. Braden suggests the only reference to SR to be found in the Seattle Library reference section is tied to the weather. Science acknowledges SR as a sensitive indicator of temperature variations and worldwide weather conditions. Braden believes the fluctuating SR may be a factor in the severe weather conditions of recent years.

Earth's background base frequency, or "heartbeat" (Schumann's resonances), fluctuates and may be rising dramatically.

As previously stated, the Earth behaves like an enormous electrical circuit. The atmosphere is actually a weak conductor; and if there were no sources of charge, its existing electrical charge would diffuse away in about 10 minutes. There is a "cavity" defined by the surface of the Earth and the inner edge of the ionosphere, whose height fluctuates somewhat. It's been calculated that at any moment, the total charge residing in this cavity is 500,000 coulombs.

There is a vertical current flow between the ground and the ionosphere of $1 – 3 \times 10^{-12}$ amperes per square metre. The resistance of the atmosphere is 200 ohms. The voltage potential is 200,000 volts. There are about 2,000 lightning storms at any given moment worldwide. Each produces 0.5 to 1 ampere, and these collectively account for the measured current flow in the Earth's "electromagnetic" cavity.

Schumann's resonances are quasi standing-wave electromagnetic waves that exist in this cavity. Like waves on a string, they must be potentiated or "excited" in order to be observed. They are not caused by internal terrestrial factors or Earth's crustal movements or the core, which does produce magnetic fields. They seem to be related to electrical activity in the atmosphere, particularly during times of intense lightning activity. So long as the properties of Earth's electromagnetic cavity remain about the same, these frequencies remain the same. Presumably there is some change due to the solar sunspot cycle, as the Earth's ionosphere changes in response to flares and mass ejections during the 11-year cycle of solar activity. High-energy charges coming off the Sun brush across the upper atmosphere, ionising there.

Since the Earth's atmosphere carries a charge, a current and a voltage, it is not surprising to find such electromagnetic waves. The resonant properties of this terrestrial cavity were first predicted by W. O. Schumann in 1952 and 1957, and first detected by Schumann and Konig in 1954.

Much of the research in the last 20 years has been conducted by the US Department of the Navy, which uses ELF signals for communication with submarines. However, little attention is given by the military and defence contractors to issues of psychobiological health and well-being.

Between the nearly perfectly conducting terrestrial surface and ionosphere, a resonating cavity is formed. Broadband electromagnetic impulses, like those from lightning flashes, fill this cavity and create globally the so-called Schumann's resonances at frequencies in the range of 5–50 Hz (Schumann, 1952; Bliokh et al., 1980; Sentman, 1987). The nominal average frequencies observed are 7.8, 14, 20, 26, 33, 39 and 45 Hz, with slight diurnal variation (Sentman and Fraser, 1991).

Standard magnetometers are not able to measure Schumann's resonances, and even the search coil (i.e., pulsation) magnetometers, which most often sample at about 0.1 Hz, do not allow such studies. Special equipment is thus needed (see, for example, Sentman and Fraser, 1991).

Current findings suggest:

1. Schumann's resonances are actually observed by experiment to emerge at several frequencies related to brain waves. They range between 6 and 50 cycles per second, specifically 7.8 (alpha), 14 (low beta), 20 (mid beta), 26 (high beta), 33 (low gamma), 39 (gamma) and 45 Hz (gamma), with daily variation of about ±0.5 Hz.

2. The strongest of the seven resonances is 7.83 Hz, in the alpha brain-wave range. If the rise in resonance continues, this primary resonance, the Earth pulse, changes from sub-band low alpha (7–10 Hz) to sub-band high alpha (10–12 Hz), perhaps influencing our ability to relax deeply, balance and integrate our mind/body connection. It could influence REM sleep and dreaming. If it continues to rise, it will breach the threshold into "fast" beta activity. Low beta (12–15 Hz) is associated with lack of focused attention, and can even indicate attention deficit disorder.

3. The amplitude (i.e., intensity) of the Schumann's resonances is not constant, and appears to be extremely dependent upon tropical (and hence global) temperature. Indeed, preliminary results seem to indicate that a mere one-degree increase in temperature correlates with a doubling of the SR. This could not be more significant, as it is unknown what psychobiological effect these fluctuations could have on humans.

SR AND GLOBAL TEMPERATURE CHANGES

One of the most crucial questions in science today centres on whether or not the planetary temperature is rising, falling or remaining unchanged. Recently global warming has been acknowledged by most in the field, and human interference (technology) is implicated.

On one hand, analyses of thermometer measurements of near-

surface global (land and sea) air temperatures suggest the planet has been warming in recent decades. But satellite measurements of the planet's lower atmospheric temperature show no warming from 1979 to 1998.

Temperature data from weather balloons launched throughout the world reveal variations and trends in global temperatures that correspond to those found in the satellite-based measurements. Analysis of pressure thickness measurements from these same balloons also shows no warming in recent decades. It's no wonder we have such an ongoing "heated debate" about the recent temperature history of the Earth! Yet most people recognise that their local weather is markedly different than in past decades.

Scientists have suggested lately that another method may exist to monitor planetary temperature accurately. The idea is simple, though the underlying physics of the processes is complex. The method is based on the well-known fact that thunderstorms and lightning strikes in many parts of the world are directly related to lower-atmospheric air temperatures. Higher temperatures produce more lightning strikes, while lower temperatures tend to depress lightning activity.

Lightning discharges occurring anywhere in the world produce electromagnetic pulses that spread away from the source. Much of the energy is quickly degraded, but some of the energy the lightning produces falls in the extremely low frequency/long-wavelength domain of the electromagnetic spectrum. At these long wavelengths, the energy from a lightning strike is able to circumnavigate the Earth without serious degradation. This low-frequency/long-wavelength energy creates SR signals which can be detected throughout the world.

Lightning discharges occurring anywhere in the world produce electromagnetic pulses that spread away from the source.

Understanding SR waves requires a basic appreciation of the vertical structure of the atmosphere. In the upper reaches of the ionosphere, incoming ultraviolet radiation and soft X-rays affect atoms or bonded groups of atoms, causing gains or losses of negatively charged electrons. This interaction creates an environment of positively and negatively charged particles of the high atmosphere that, among other interesting qualities, can readily conduct electricity.

The bulk of our insulating atmosphere lies between two conducting layers of the Earth's surface and the lower boundary of the ionosphere. This spherically concentric cavity, the Earth/ionosphere cavity, is bounded by those electrically conducting walls. Again, lightning discharges within the cavity produce electromagnetic pulses that spread away from the source in the extremely low frequency domain, and the conductive walls of the cavity produce some interesting effects for the low-frequency energy.

For example, energy with a frequency near 7.5 Hz would have a wavelength of about 40,000 km (recall that wavelength = speed of light / frequency). Because this wavelength equals the circumference of the Earth, the energy is able to circumnavigate the Earth/ionosphere cavity without serious degradation. The 100 or so lightning bolts occurring each second in the 1,000 lightning storms around the world contribute to the energy in the 7.5 Hz portion of the spectrum, which can be measured anywhere on the planet. It is these resonance properties of this global spherical capacitor or resonator) that Schumann predicted over 40 years ago.

In an article published in *Science*, MIT scientist Earle Williams (1992) constructed a powerful argument that links Schumann's resonances to convection and ultimately to widespread tropical and/or global temperature. Williams concluded that a 1°C warming in the tropics should result in a fourfold increase in lightning activity, and he presented empirical data from several locations to support his conclusion. He noted that any measurable parameter nonlinearly related to temperature could be extremely useful in assessing the most subtle changes in global temperature. Others have presented different sensitivities: Price (1993) concluded that a 1°C warming would increase global lightning activity by 7%; Price and Rind (1994) found a 5–6% increase per 1°C sensitivity; while Reeve and Toumi (1998) found the sensitivity to be near 40% per 1°C. Regardless of the exact sensitivity, all these scientists conclude that lightning increases with even moderate amounts of warming worldwide. More lightning would generate a stronger SR, which may be useful in monitoring planetary temperatures.

The link between SR and the number of lightning strikes is supported by a mean day/night temperature fluctuation pattern. A diurnal pattern of worldwide lightning exists with three maxima recorded regularly due to the large number of mid- to late-afternoon thunderstorms in land areas of Africa, South America, and Southeast Asia and Australia. (Storms are first generated in Asia; later they form in Africa; and later each day they arise in South America.)

Global warming has been linked to the suspected rise in SR, and is a threat to its synchronisation with our brain waves. Small changes in temperature pump up into large signals in extremely low frequency (ELF) resonances. Long-term monitoring and study of global climate changes via measurements of ELF electromagnetic waves needs to be conducted more closely. Monitoring the intensity and frequencies of the lightning-induced ELF SR could help monitor changes in the Earth's climate over time.

One Israeli program proposed setting up two or three widely separated ELF field sites. A suggested site for a permanent SR monitoring station was in the Negev Desert in Israel. Members of this proposal want to develop, test and install the appropriate software for the automatic electromagnetic monitoring and preliminary processing of the incoming data. They suggested that simultaneous measurements could be made in Russia and Sweden to test the global nature of the ELF signals measured in Israel. The continuous ELF data measured in Israel could be compared with other ELF data sets from other locations around the world, such as Hungary, USA or Japan. Furthermore, the relevant global climate data sets—such as surface temperature, satellite observations of the global distribution of deep convection, and global atmospheric water vapour measurements—could be used for comparisons with SR data to check the reliability of the "global thermometer" hypothesis.

A systematic study of SR parameters during high-energy particle precipitation events has shown that protons and electrons with energies above 1 MeV ionise the upper boundary of the Earth/ionosphere cavity. This leads to an increase in the resonance frequency and a decrease in the damping of the first Schumann's resonance, as derived from measurements at Arrival Heights, Antarctica. The study used

Continued on page 77

Continued from page 47

the nine strongest solar proton events of the past Solar Cycle 22 and high-energy electrons emitted periodically from co-rotating interaction regions in the solar wind during 1994–95. The variation of the SR parameters is in qualitative agreement with current SR theories. The study also showed that high-energy particle precipitation (solar ejecta) is not the only relevant source affecting SR parameters. The findings constitute a so far little-explored aspect of solar/terrestrial interaction.

FACILITATING OUR POTENTIAL

In conclusion, we postulate that: (1) we are complex electrodynamic, rather than merely chemical beings, sensitive to natural and artificial EM fields; (2) SR frequencies coincide with human brain waves, affecting subtle and gross brain-wave generation, regulating homoeostasis, healing and psi; (3) there is strong correlation between human behavioural disturbance and geomagnetic field turbulence or isolation from SR frequencies.

As human beings we have extraordinary potentials we have hardly begun to study, much less understand. Creative gifts, intuitions and talents that are unpredictable or emergent may become stabilised in generations to come. Hopefully, we can learn to understand both our emergence from an essentially electromagnetic environment and facilitate our potential for healing, growth and non-local communication. ∞

About the Authors:

• **Richard Alan Miller** started his professional career as a physicist, biophysicist and instrumentation specialist. In late 1972 he began his foray into paraphysics with experiments in Kirlian photography and developed a field theory to explain the phenomenon. He is an expert in growing and marketing botanicals, and set up his own company, Northwest Botanicals. Visit http://www.nwbotanicals.org for a listing of his writings on subjects as diverse as metaphysics, parapsychology and alternative agriculture. He is currently writing a book on ESP self-induction. Richard is available for lectures and as an outside consultant. He can be contacted at OAK Publishing, Inc., 122 SW 5th Street, Grants Pass, OR 97526, USA; telephone +1 (541) 476 5588, fax +1 (541) 476 1823, email DrRam@magick.net.

• **Iona Miller** is a multimedia artist, hypnotherapist, web author and researcher who works through the Asklepia Foundation (http://www.asklepia.org), *Chaosophy Journal* and *JNLRMI* on the relationship between experiential journeys, physics, healing, creativity, dreams, consciousness and chaos theory. She has been collaborating with Richard Alan Miller since the mid-1970s; although they divorced in 1994, they continue to work together on leading-edge studies into consciousness, neurotheology, Qabalah, alchemy and the nature of reality. Email Iona at iona_m@yahoo.com, and visit her homepage at http://www.geocities. com/iona_m/.

Notes and References

• The authors give special thanks to Betty Daly-King of Western Australia for getting them started on the completion of Lewis B. Hainsworth's original works on this subject.

• Two background papers by Hainsworth are appended to the article "On the Possible Effects of Changes in Schumann's Resonances on Human Psychobiology" at website http://www.nwbotanicals.org. Appendix 1: The Effect of Geophysical Phenomena on Human Health (first published in *Speculations in Science and Technology*, vol. 6, no. 5, December 1983); Appendix 2: Electrical Technology and Human Evolution (*Speculations in Science and Technology*, vol. 11, no. 2, 1987)

• Additional references for this article can be found at http://www.nwbotanicals.org.